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# United States Patent [19]

**Hornung**

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[45] **Date of Patent: Dec. 5, 1995**

[54] **PRECISION CRIMPING APPARATUS**

[75] Inventor: **Craig W. Hornung**, Harrisburg, Pa.

[73] Assignee: **The Whitaker Corporation**, Wilmington, Del.

[21] Appl. No.: **223,353**

[22] Filed: **Apr. 5, 1994**

[51] **Int. Cl.**[6] ..... **A01R 43/055**

[52] **U.S. Cl.** ..... **72/402**; 72/424; 29/753

[58] **Field of Search** ..... 72/402, 410, 452, 72/424; 29/753, 751

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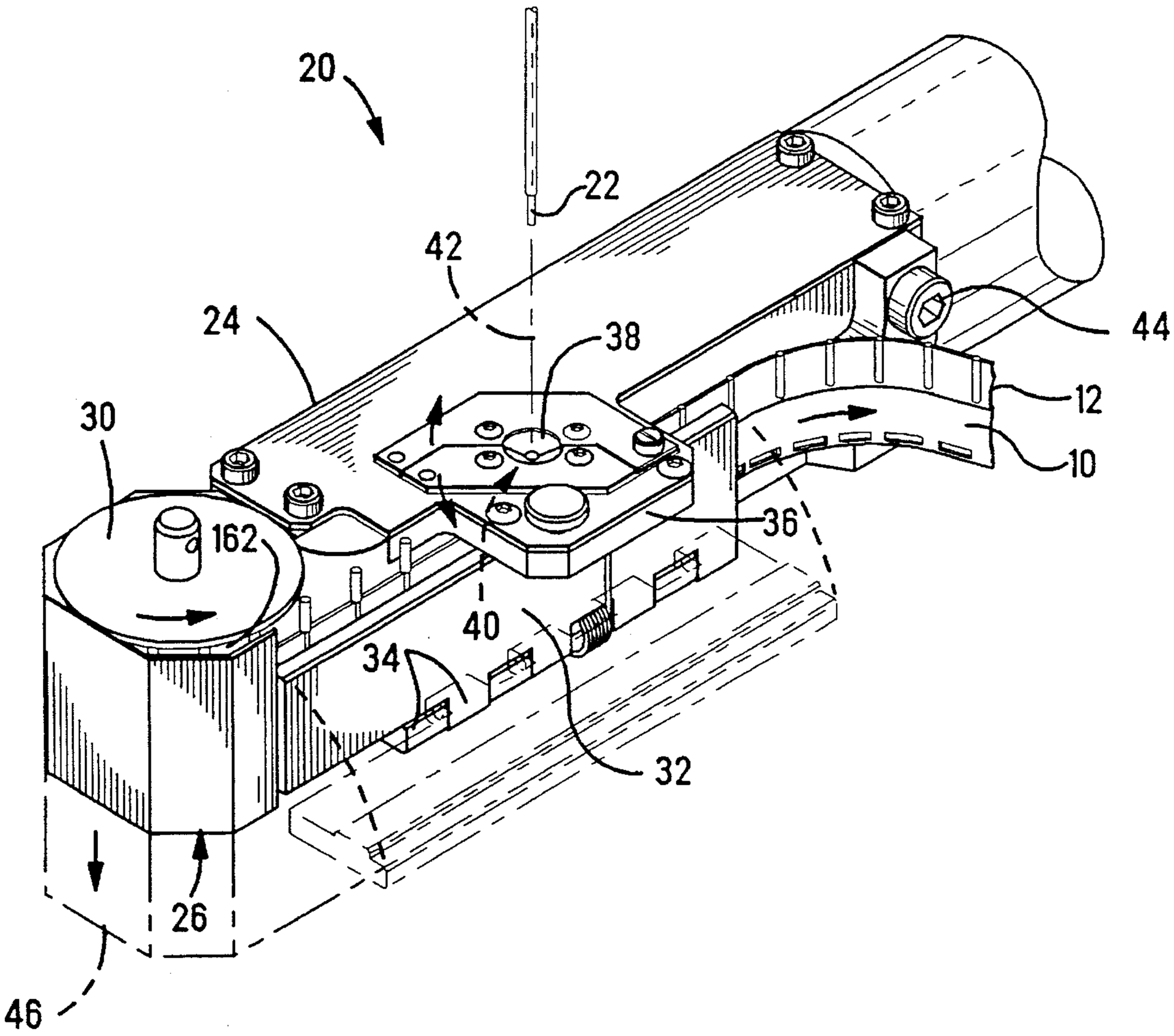
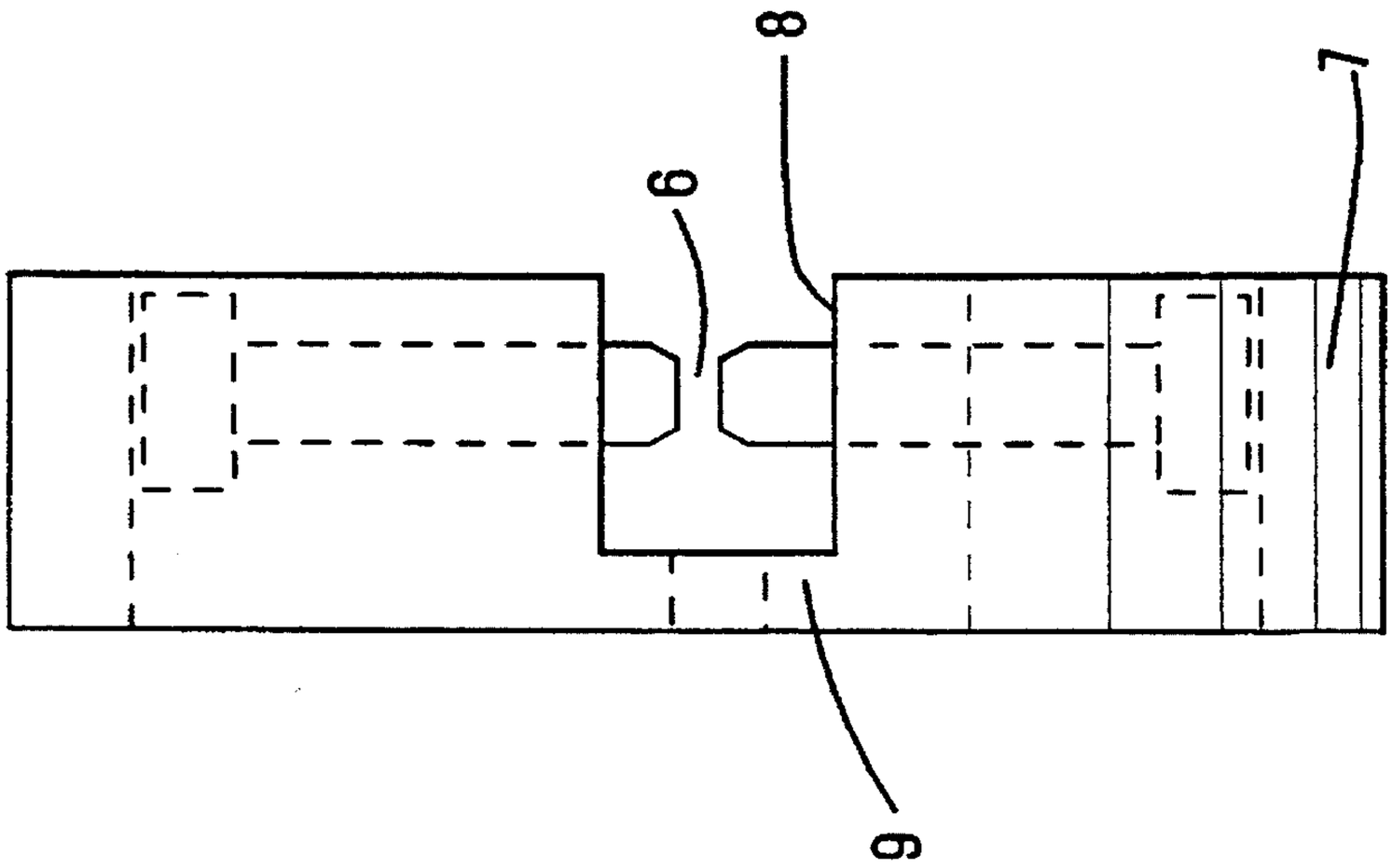
*Primary Examiner*—Daniel C. Crane

[57] **ABSTRACT**

The present invention is a crimping tool that utilizes a die member having a die opening for receiving a terminal therein to be crimped. The tool includes a crimping station that is within the die opening. The terminals are arranged on a carrier strip and are automatically fed into crimping position within the opening of the die while the terminal remains in position on the carrier strip. The feeding mechanism pivots the strip of terminals away from the crimping dies, feeds the strip of terminals one position, and then pivots the strip back into position so that the next terminal is moved into crimping position within the crimping die opening. A single cam member is provided that is moved by a linear actuator, such as an air cylinder, and effects and controls all functional operating motions for the mechanisms of the tool, including actuating the crimping dies and operating the terminal feed mechanism.

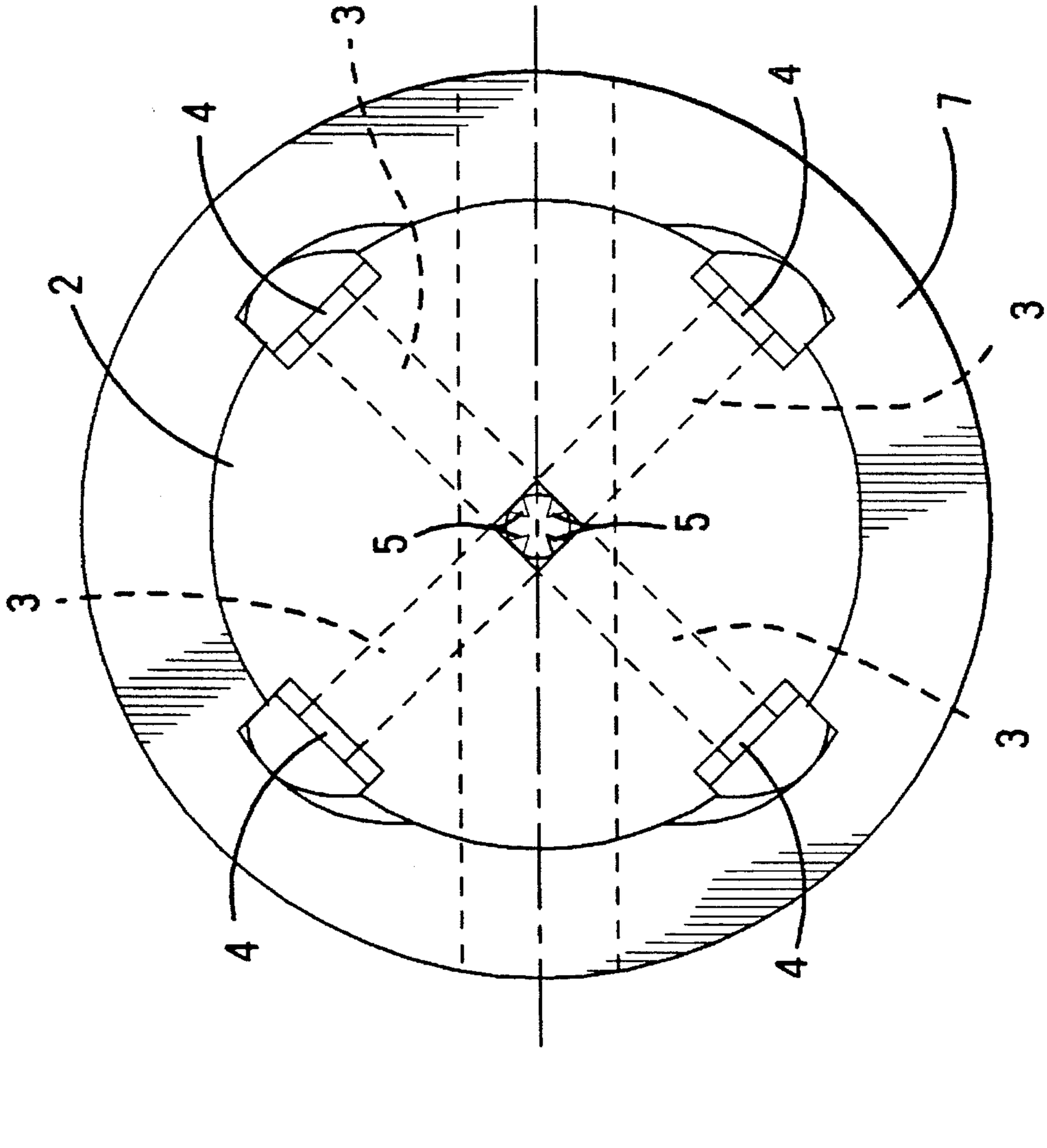
**16 Claims, 10 Drawing Sheets**






PRIOR ART

FIG. 2




PRIOR ART

FIG. 1

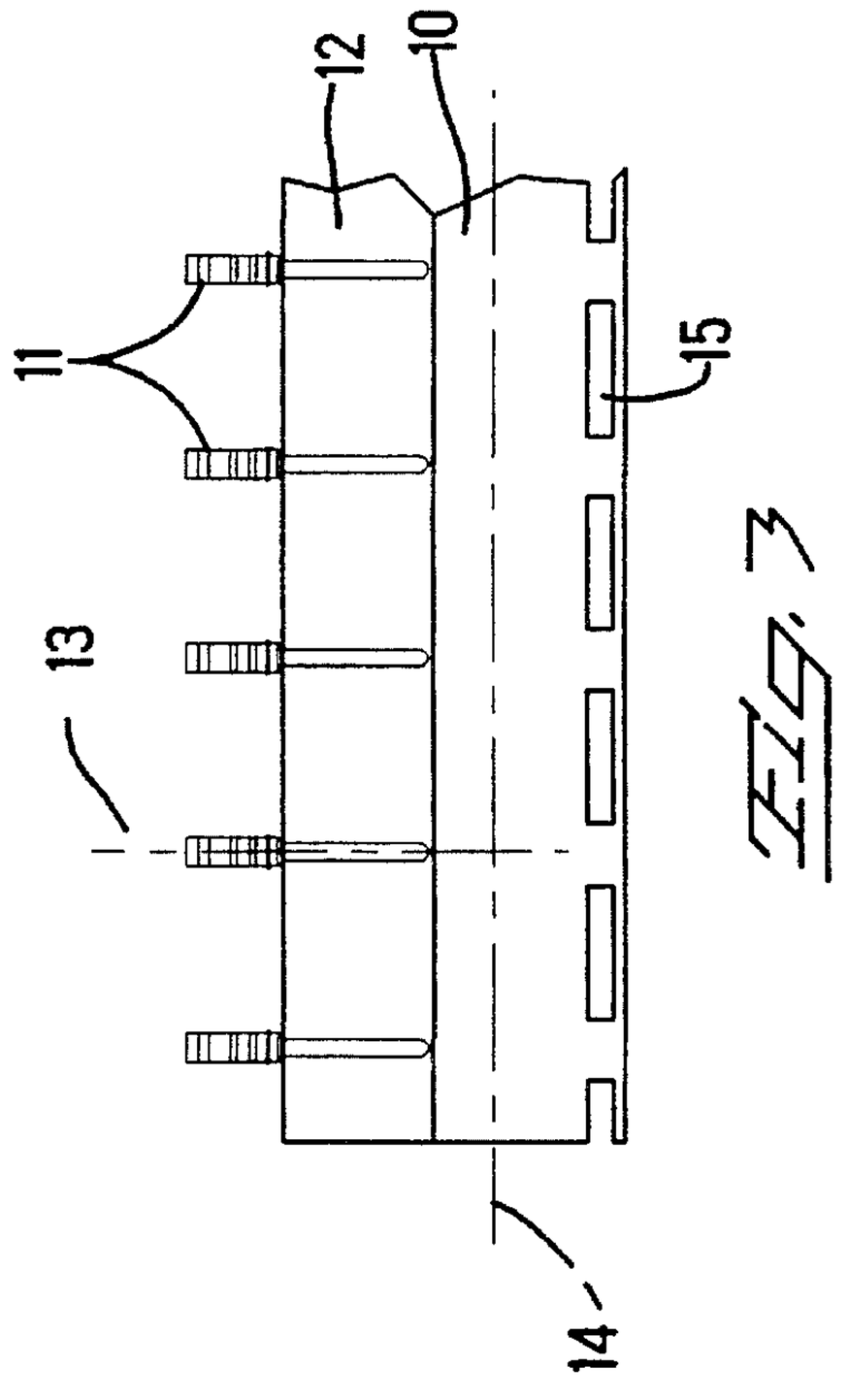



Fig. 3

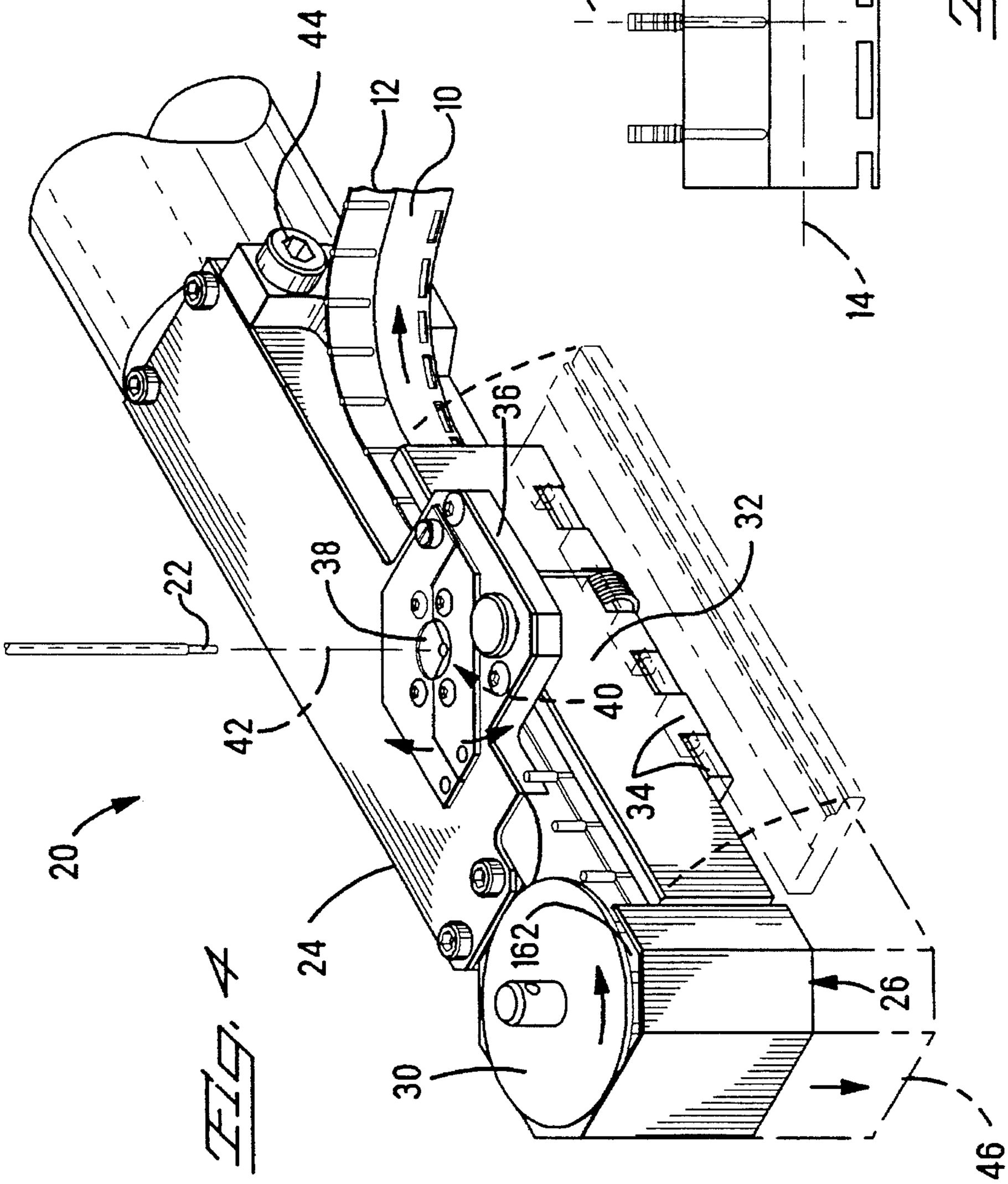
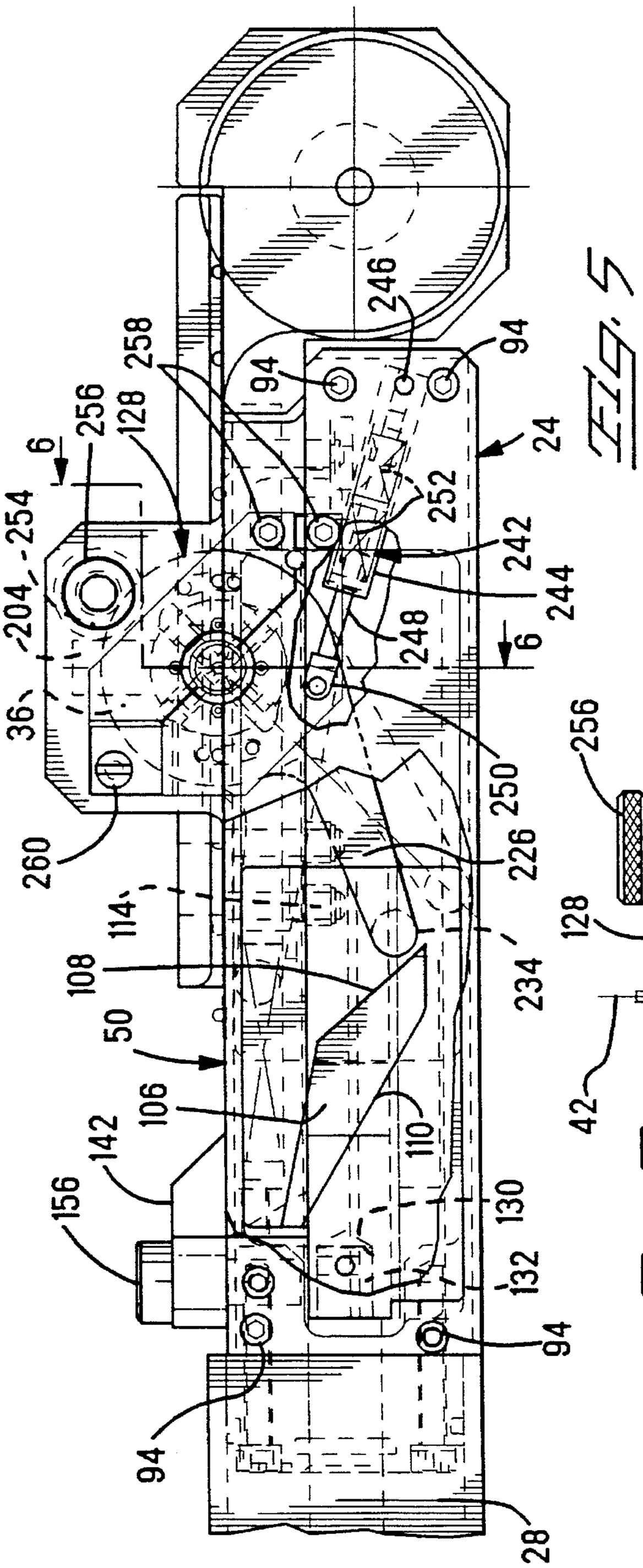



Fig. 4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128
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244
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50
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132
94
28

FIG. 5

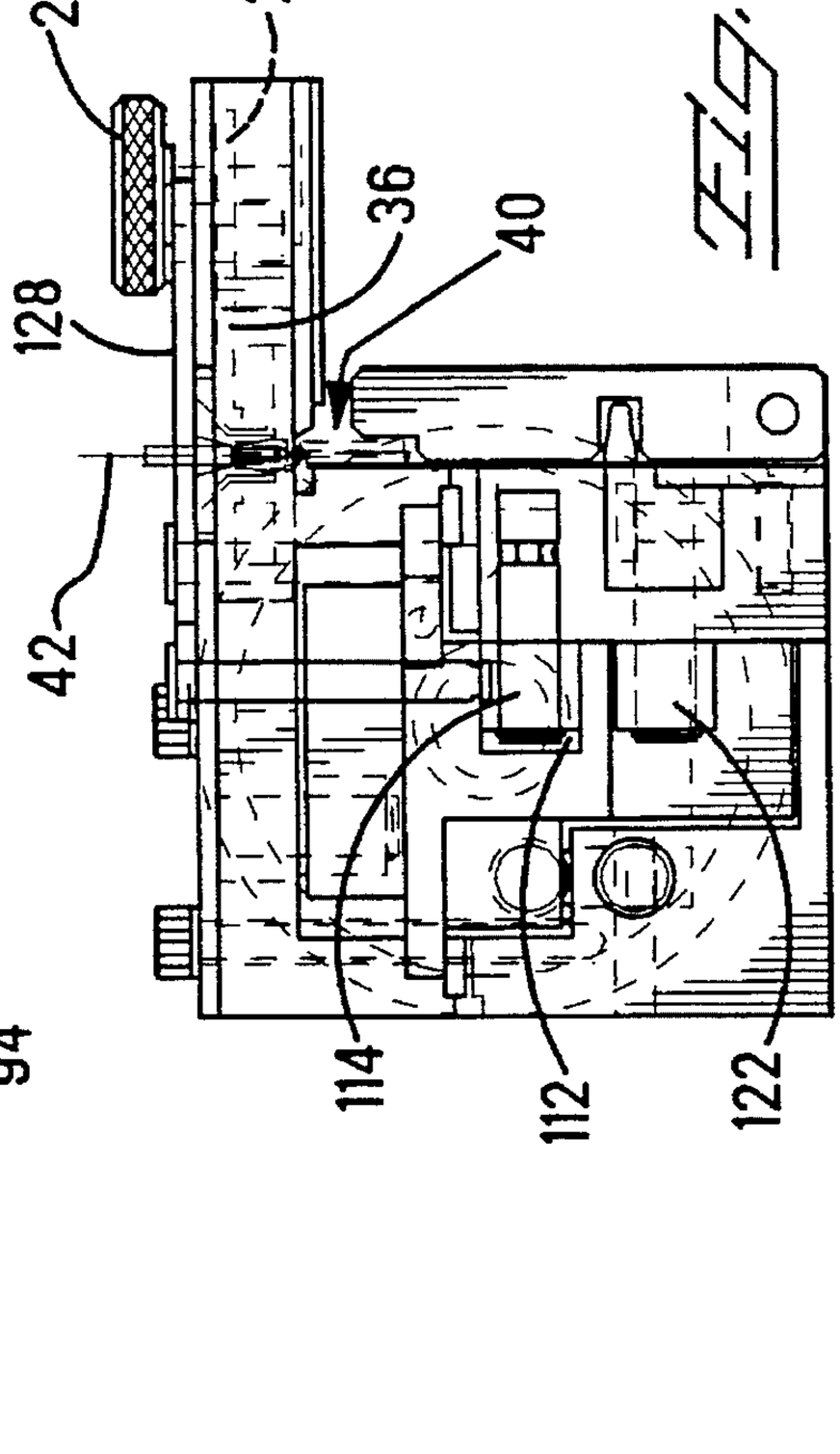
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FIG. 6

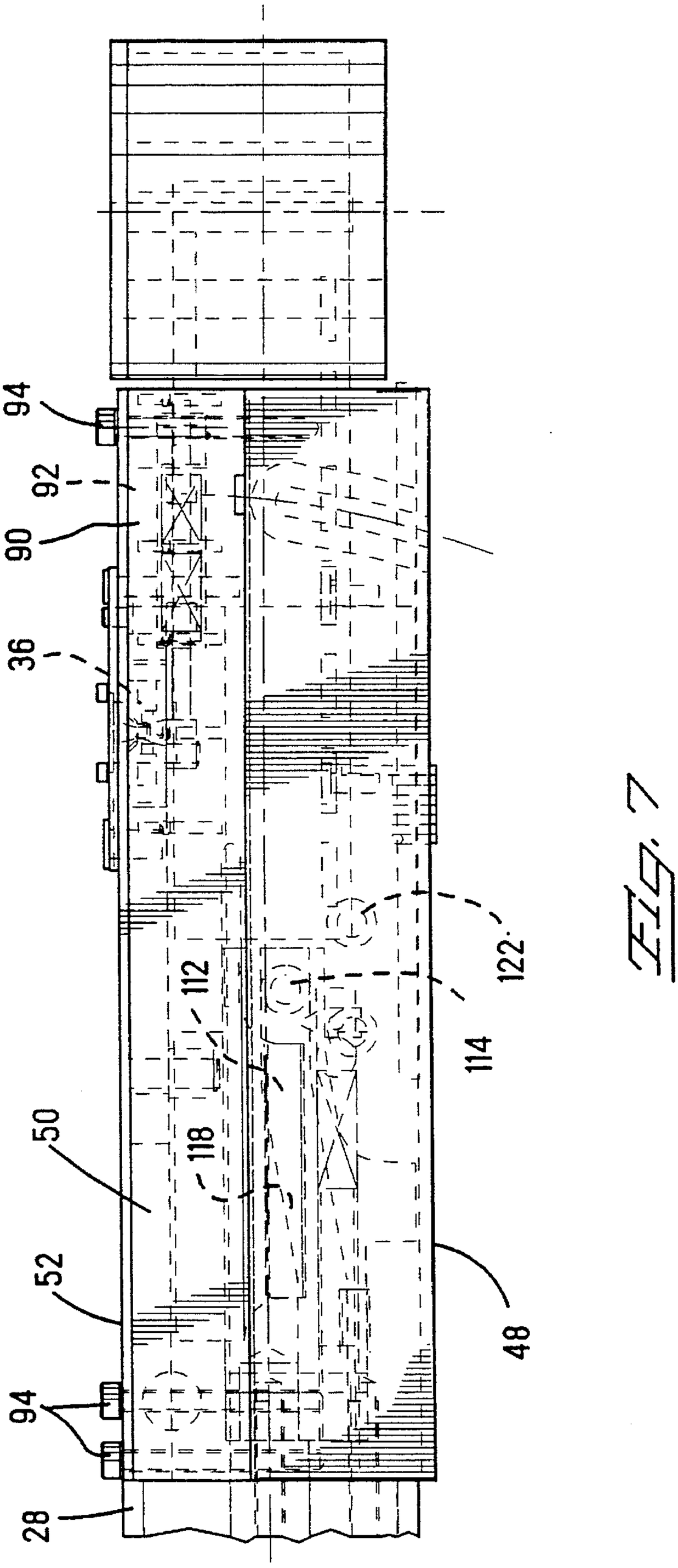


FIG. 7

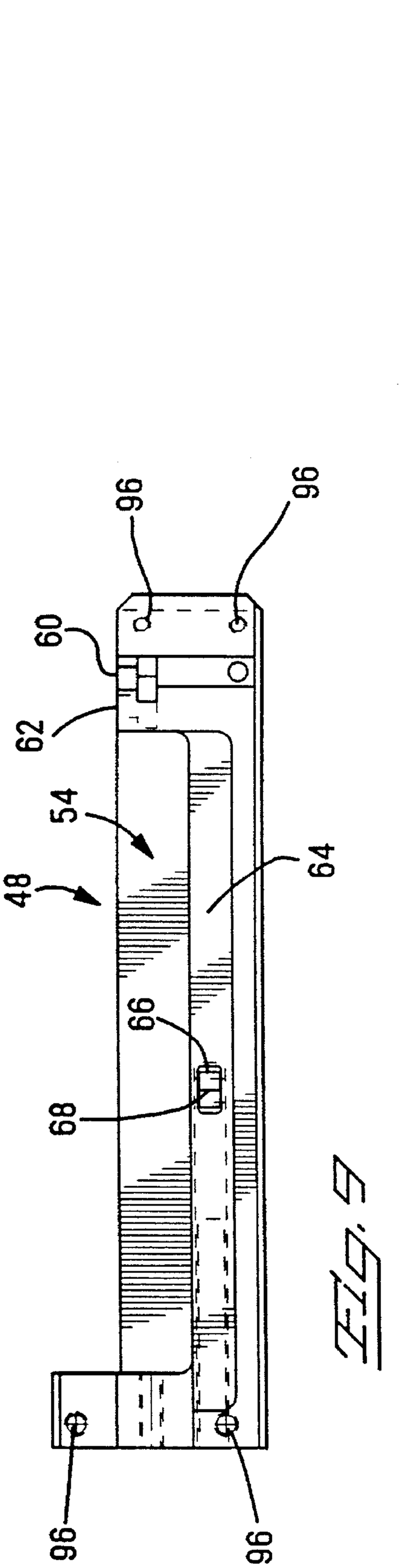


FIG. 9

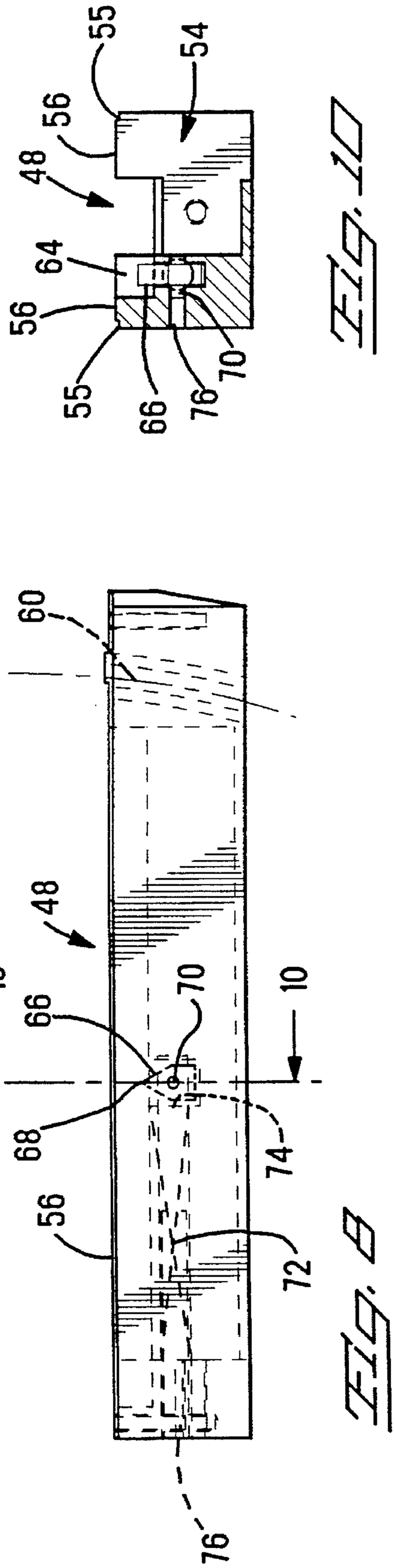


FIG. 8




FIG. 10

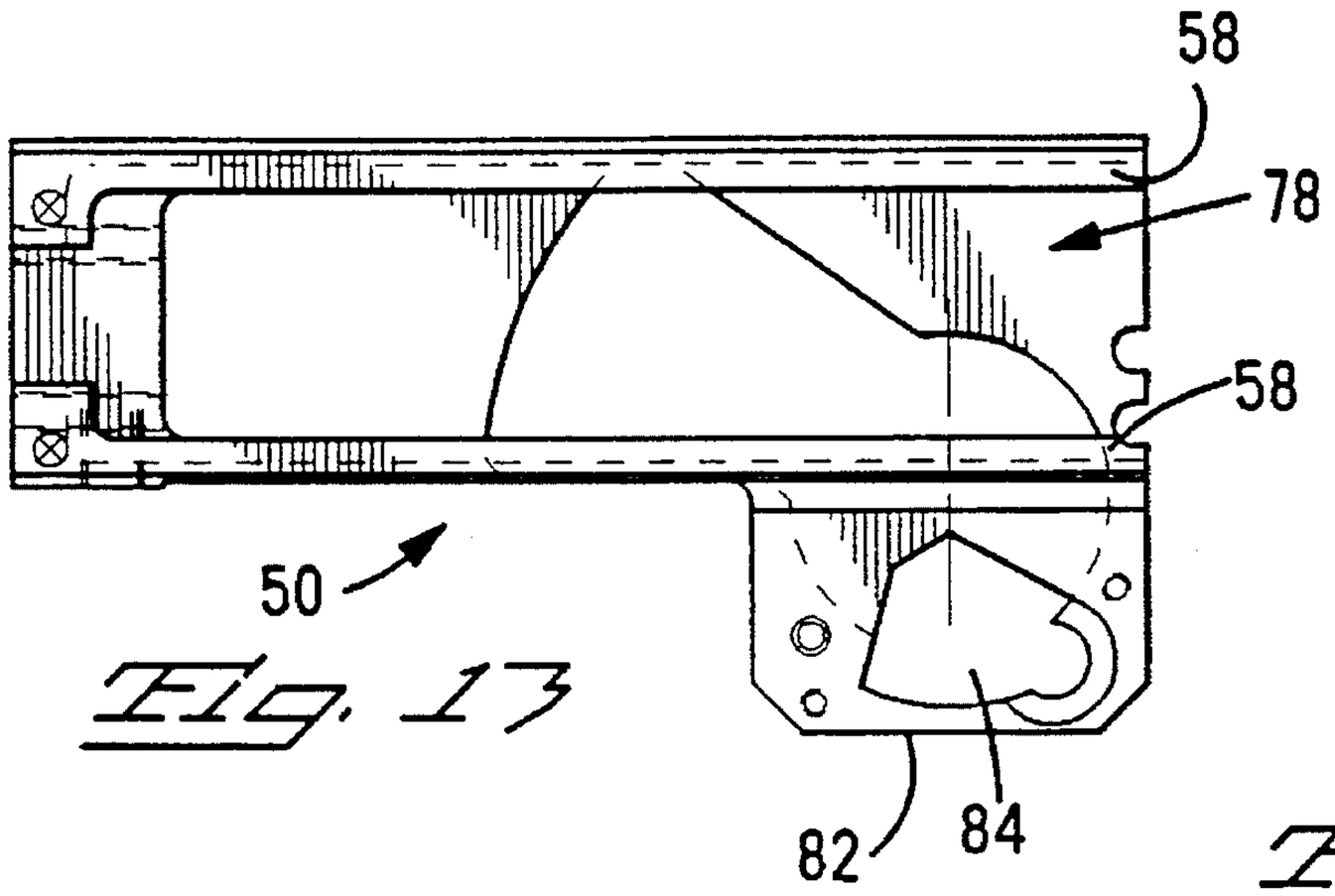


Fig. 13

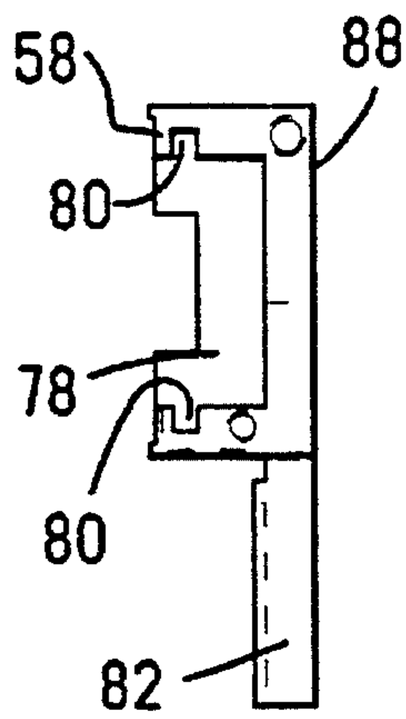


Fig. 14

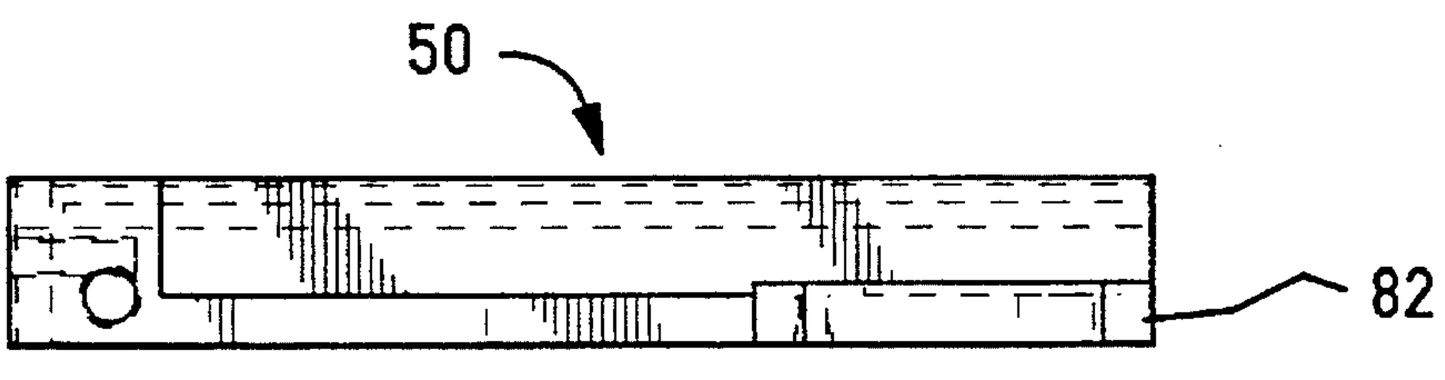


Fig. 12

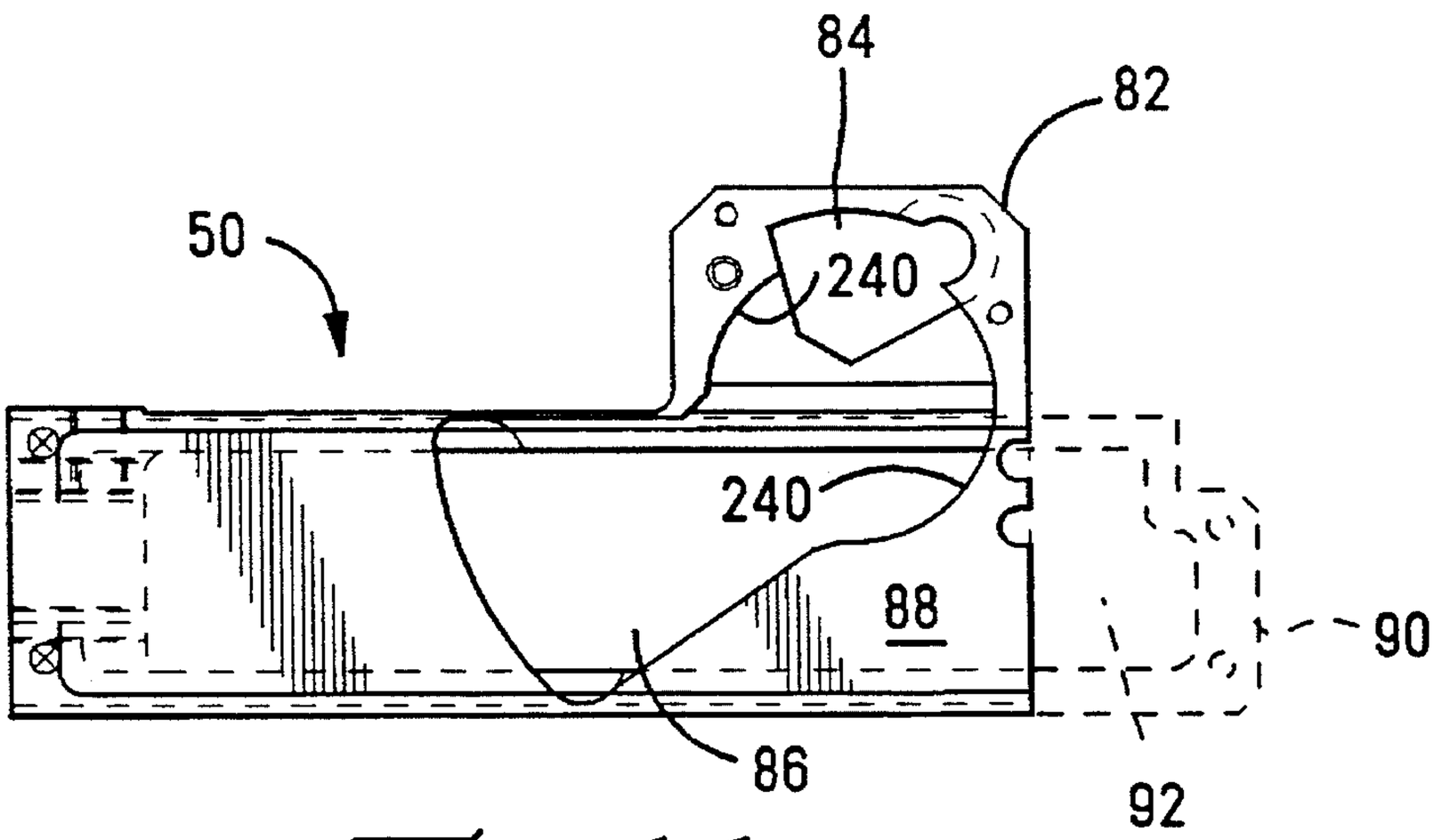


Fig. 11

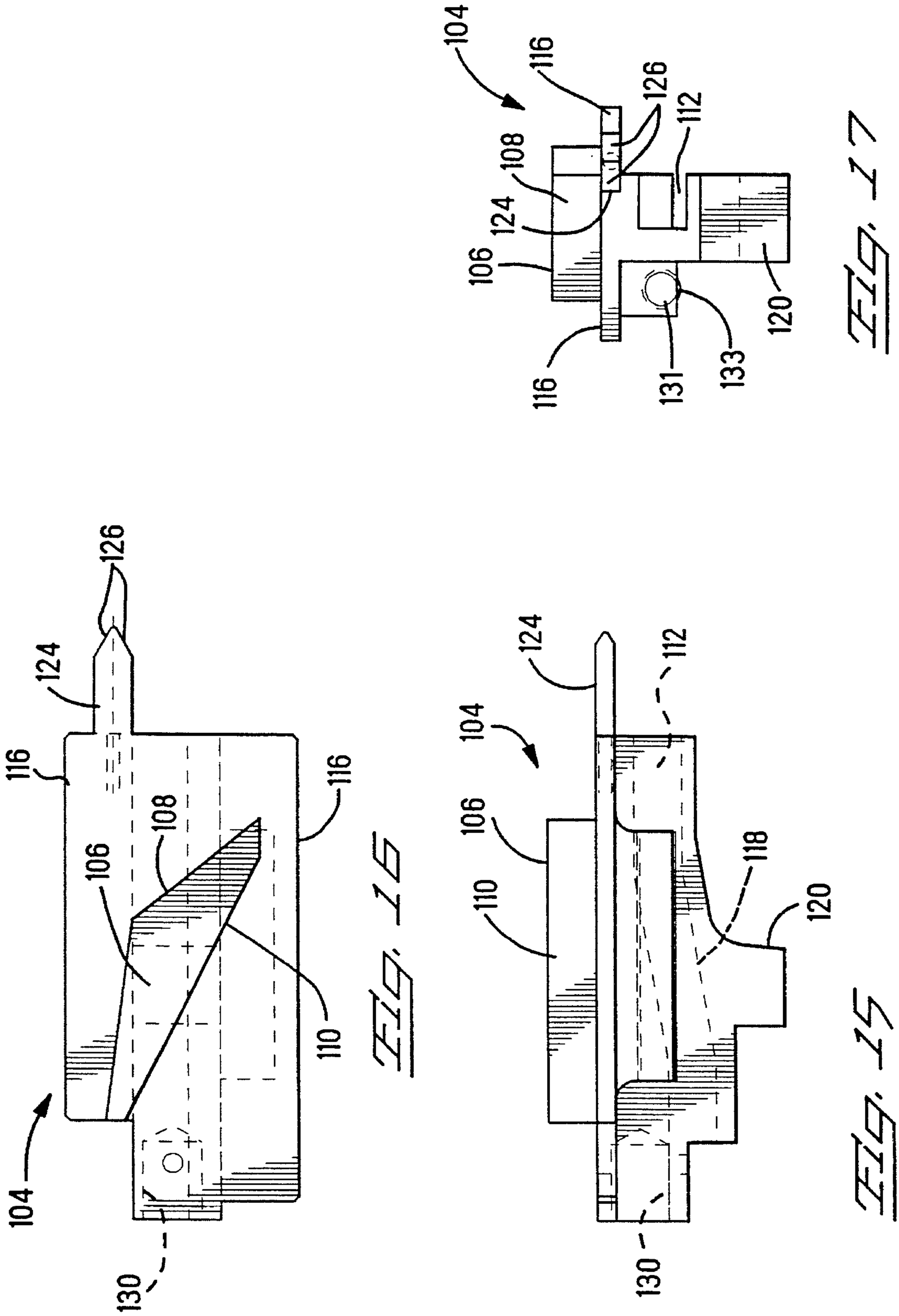


FIG. 17

FIG. 16

FIG. 15

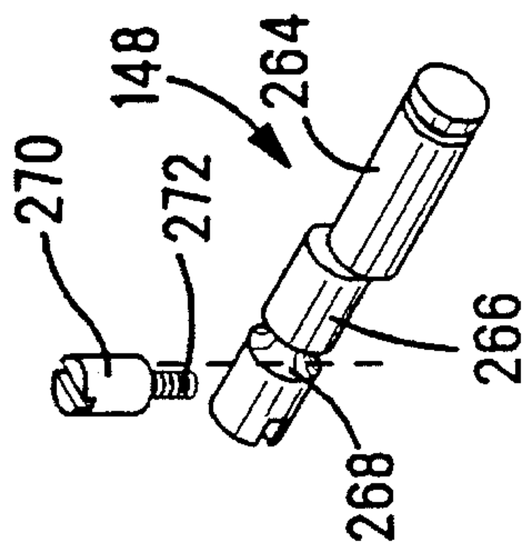


FIG. 19A

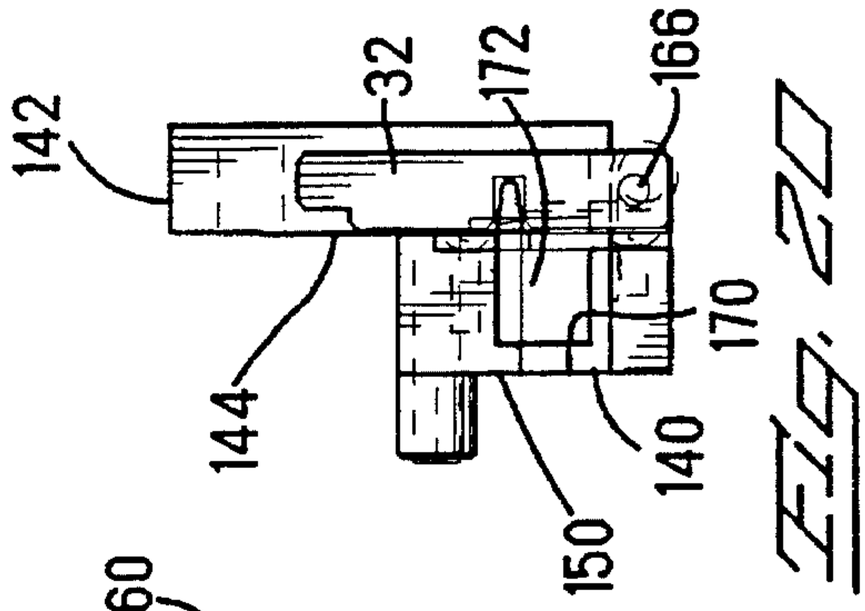


FIG. 20

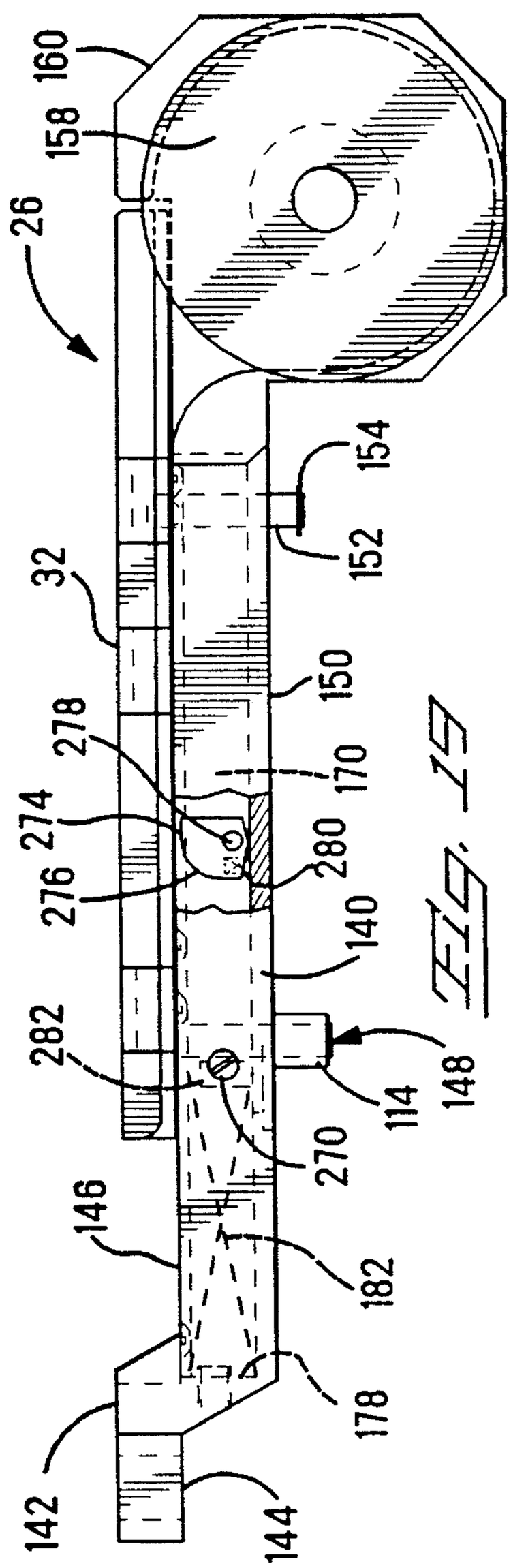


FIG. 19

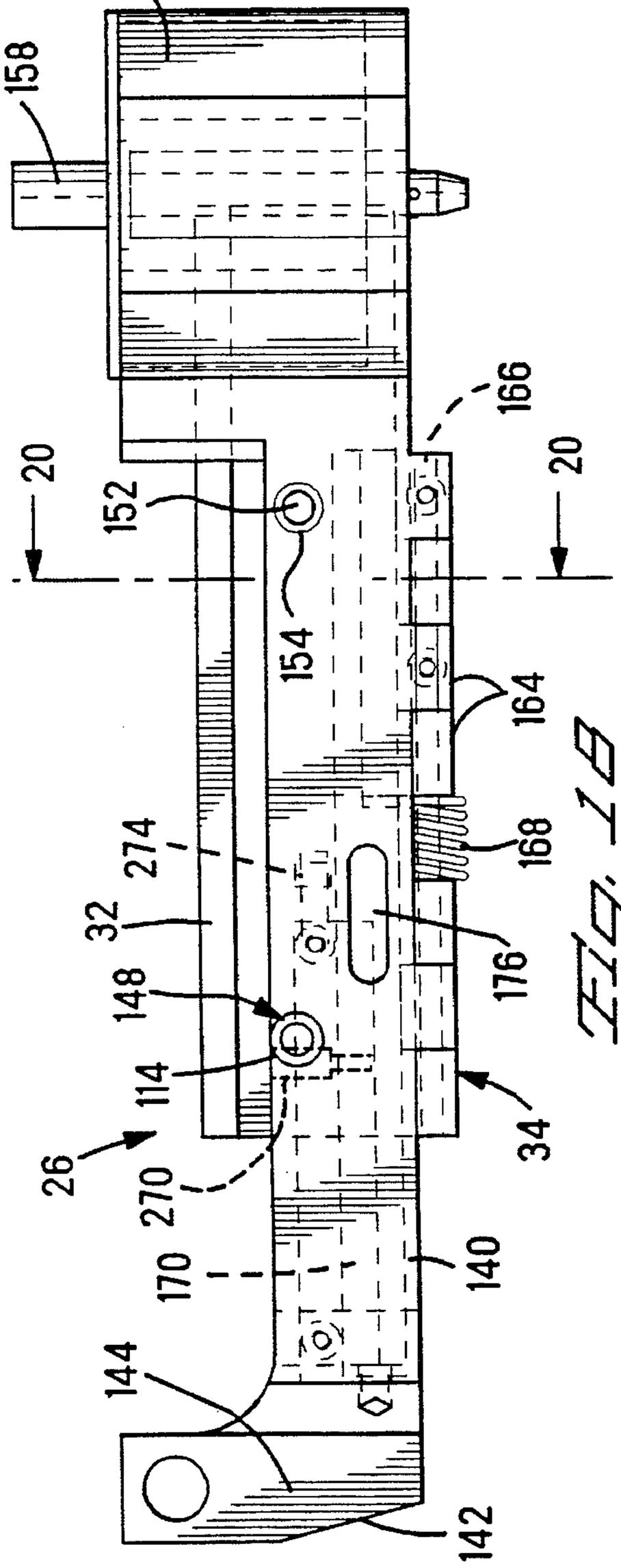


FIG. 18

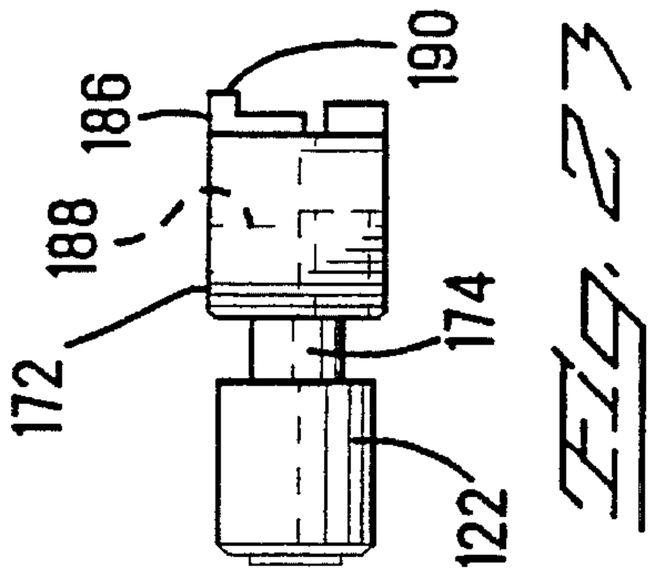


Fig. 23

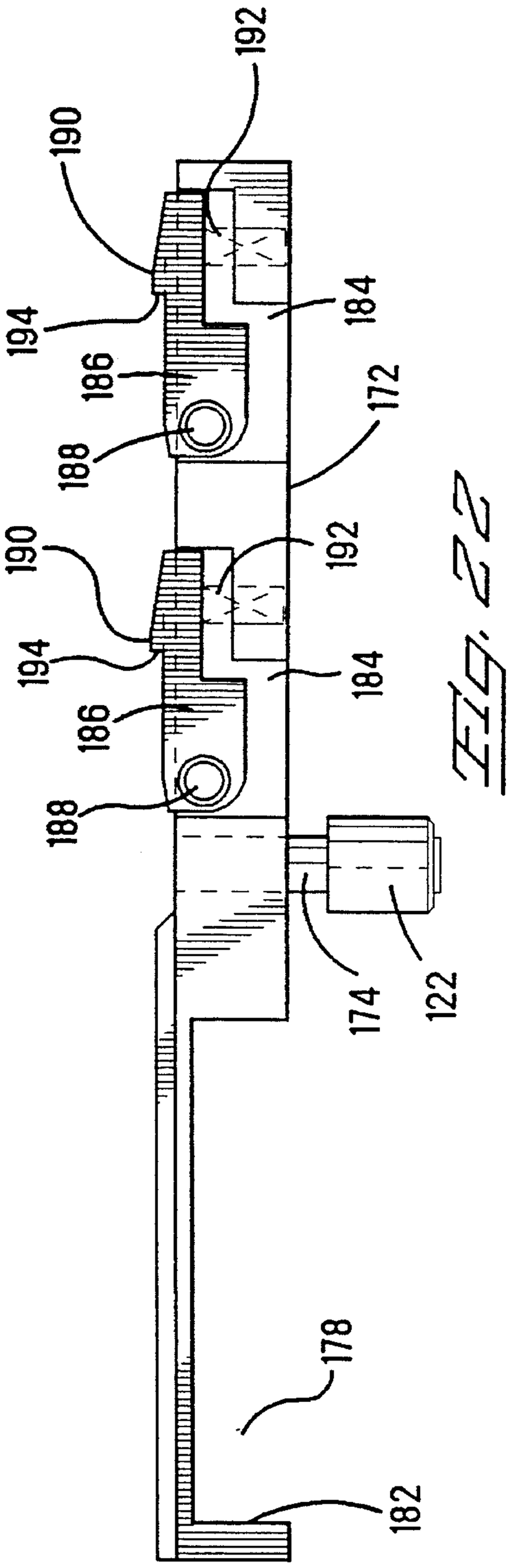


Fig. 22

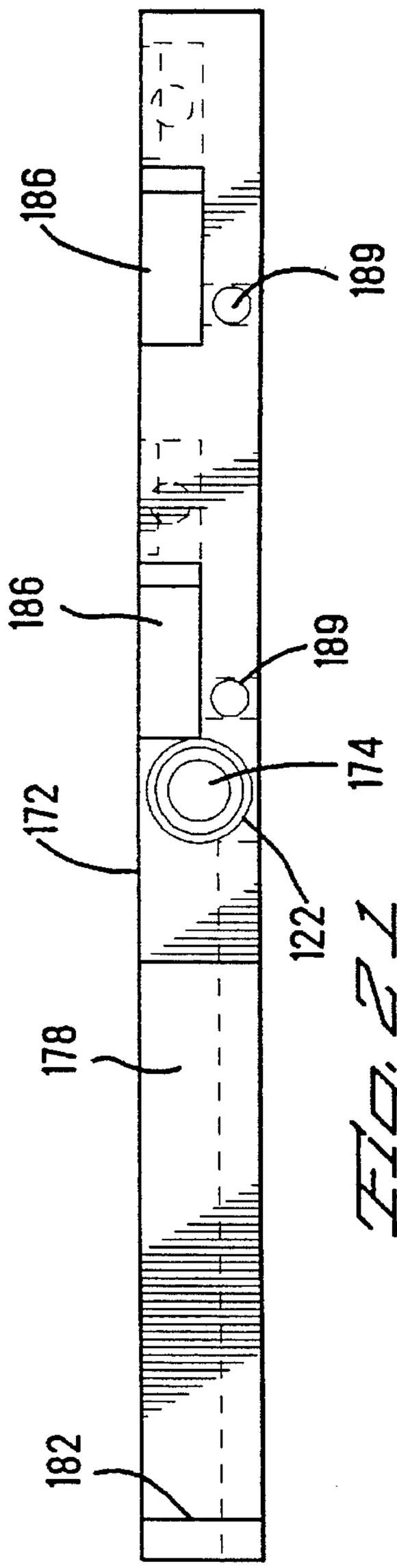


Fig. 21

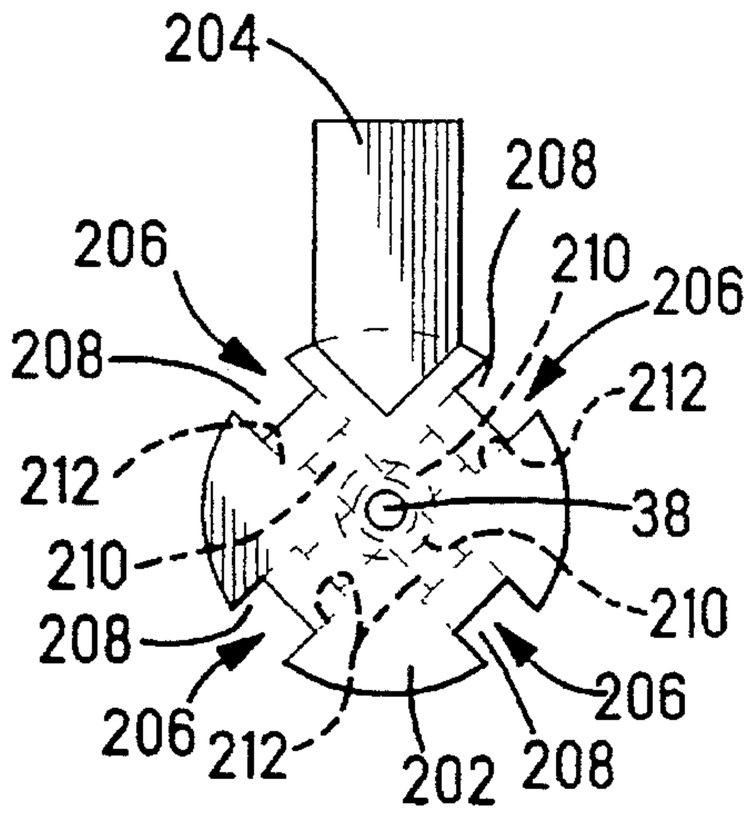


Fig. 24

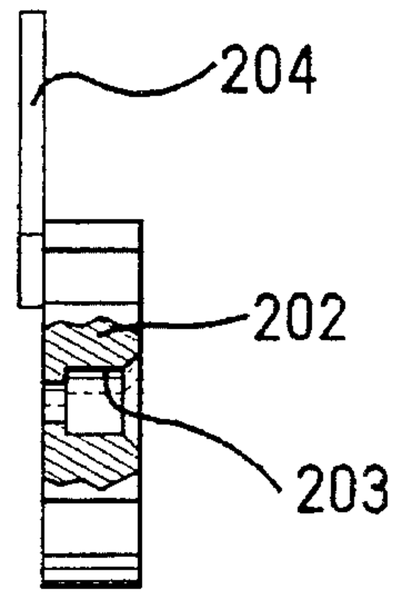


Fig. 25

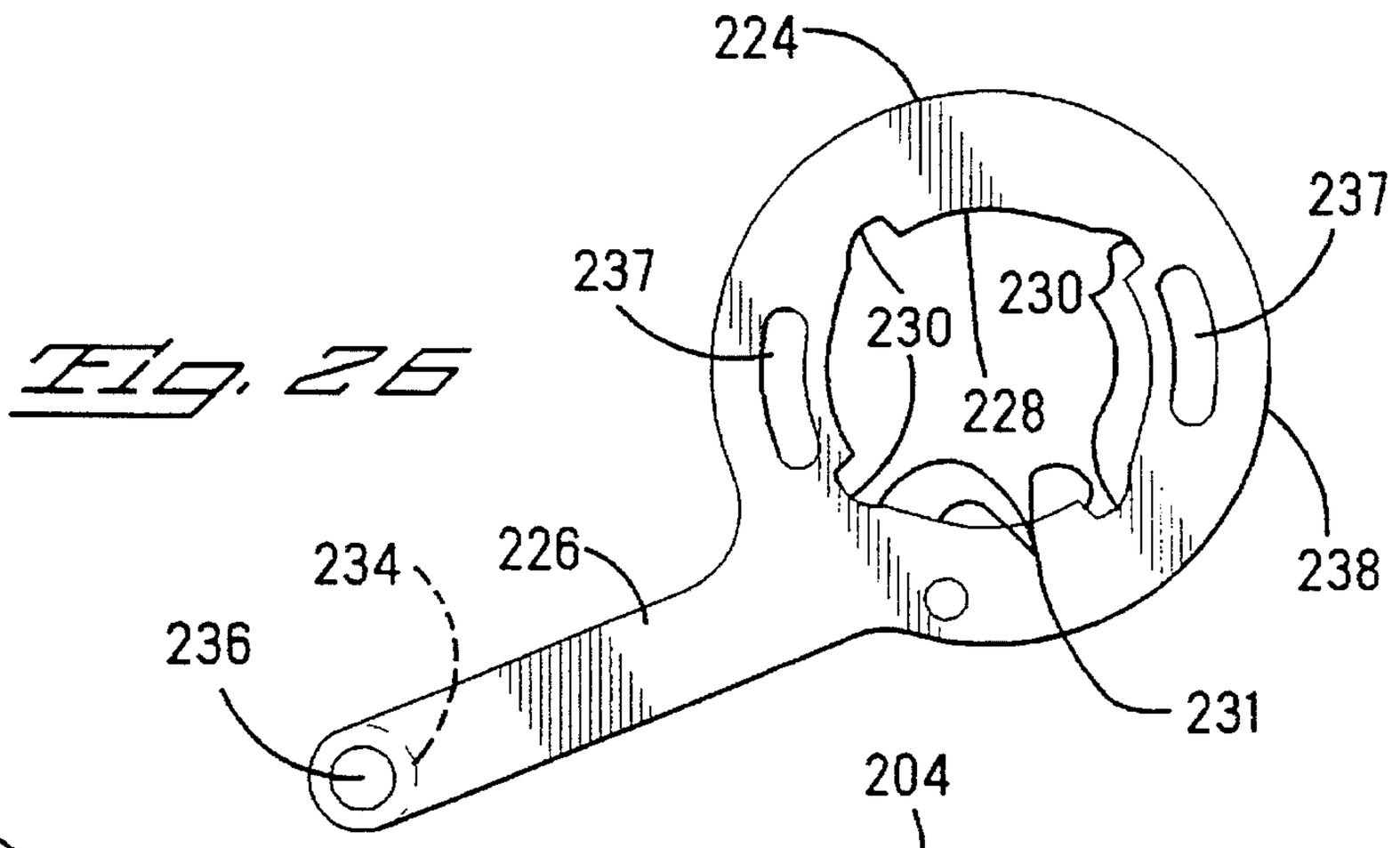


Fig. 26

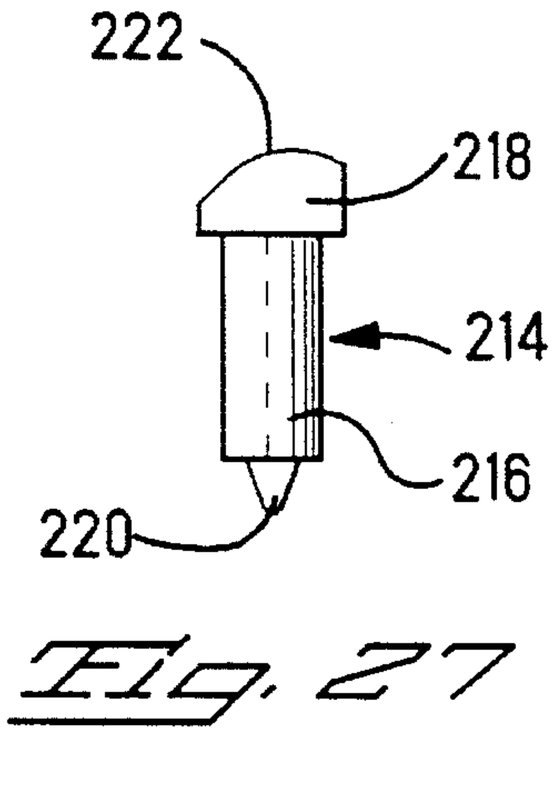


Fig. 27




Fig. 28

# PRECISION CRIMPING APPARATUS

The present invention relate to apparatus for crimping terminals onto the ends of electrical conductors including apparatus arranged to automatically feed terminals arranged on a carrier strip into the crimping station within the die assembly.

## BACKGROUND OF THE INVENTION

Machines that automatically feed electrical terminals that are arranged on a carrier strip into a crimping apparatus for crimping onto an electrical conductor typically employ a notched crimping die assembly wherein the strip of terminals is fed laterally through the notch into the crimping station between the crimping dies. A typical crimping die assembly is shown in FIGS. **1** and **2**. There, a die holder **2** is shown having four equally spaced die ways **3** formed therein, each of which contains an indentor **7** having a crimping die **5** on its end extending into a crimping station **6**, as shown in FIG. **2**. An actuating ring **7** is arranged around the die holder and includes camming surfaces that engage the outside ends of the indentors **4** so that when the ring is rotated with respect to the die holder, the indentors are cammed inwardly so that the crimping dies **9** converge in the crimping station **6**. A notch **8** is formed through both the die holder **2** and the actuating ring **7** so that the carrier strip of terminals can be fed therethrough to bring each terminal into crimping position. This notch **8**, which forms a relatively thin section **9** in the crimping die assembly, as best seen in FIG. **2**, is necessary because the axes of the terminals are arranged perpendicular to the longitudinal axis of the carrier strip, so that as the carrier strip is fed, along its axis, the terminals move laterally with respect to their axes and must clear the structure of the crimping mechanism as they are fed into the crimping station. An example of such a carrier strip and terminals are shown in FIG. **3**. There, a carrier strip **10** has a plurality of electrical terminals **11** held in place by means of a strip of tape **12** in the usual manner. Each terminal has an axis **13** that is perpendicular to the longitudinal axis **14** of the carrier strip. Additionally, the carrier strip **10** includes a row of rectangular openings **15** along an edge thereof that are used for feeding the strip in a crimping apparatus. A problem associated with this type of crimping die assembly is that crimping accuracy and consistency is sacrificed to some degree because the crimping forces as well as other forces internal to the machine will cause the assembly to deflect somewhat about the relatively thin section **9** during the crimping operation. The thin section **9** is made as thick as possible to minimize this deflection, however, if the section is too thick, it is more difficult to thread the conductor through the central opening **11** and into the barrel of the terminal without stubbing. Therefore, this becomes a compromise that still allows for substantial deflection during the crimping operation. Where accuracy of the crimp is essential, these types of crimping die assemblies cannot be used. In such cases a crimping die assembly without the notch is used so that the actuating ring completely encircles the crimping station **6** with no discontinuities in its peripheral surface. Such a crimping die assembly is used in a hand operated crimping tool part number 601966-1 distributed by AMP Incorporated of Harrisburg, Pa. and is illustrated in their publication IS7516. The crimping dies are arranged in the die ways of the die holder so that they converge onto the crimping station that is in the center of an opening in the holder. An actuating ring without a notch, that is, with a continuous peripheral surface, encircles



the holder and the crimping station and, when rotated, will cause the crimping dies to mutually converge to crimp terminal in the crimping station. The actuating ring without the notch provides a considerably stronger crimping die assembly for more accurate crimps than does one with a notch. This type of tool, however, requires that the operator insert a terminal into a positioner within the tool, then thread the end of the electrical conductor into the opening in the terminal. This die assembly structure, while providing superior crimping performance, precludes the automatic feeding of terminals on a carrier strip along the longitudinal axis of the strip and into the crimping station without complex and costly feeding mechanisms. Such a complex crimping tool utilizing a die assembly without a notch is disclosed in U.S. Pat. No. 4,774,762 which issued Oct. 4, 1988 to Gobeil. The tool disclosed in the '762 patent utilizes terminals arranged in bandoleers that are mutually attached to form a strip. Each bandoleer is fed in turn into position in alignment with the axis of the crimping station and then the terminal is pushed out of the bandoleer into the crimping station by a push rod. This requires means for locating and positioning the loose terminal prior to and during the crimping operation, in addition to the pushing mechanism.

What is needed is a terminal crimping and feeding mechanism that utilizes the stronger die assembly without the notch while providing automatic feeding of terminals that are arranged on a carrier strip. Further, the mechanism should be economical to manufacture and simple in operation so that a single linear stroke actuator will effect all necessary crimping and feeding movements.

## SUMMARY OF THE INVENTION

A tool is disclosed for crimping an electrical terminal onto the end of an electrical conductor. The tool has a frame, a crimping station within the frame and a major axis through the crimping station. The tool is of the type that receives electrical terminals spaced on a carrier strip, moves the strip to position a terminal within the crimping station, and removes the terminal from the carrier strip after crimping onto the conductor. The tool has a crimping die assembly including a die member that encircles the crimping station. A plurality of die ways are formed in the die member and a plurality of crimping dies are arranged in the die ways to move toward the crimping station and into crimping engagement with a terminal in position therein. A die actuating member encircles the die member and the crimping station and is arranged to effect the movement of the crimping dies within the die ways. A terminal feed mechanism is arranged to move the carrier strip so that a terminal is moved into position in the crimping station.

## DESCRIPTION OF THE FIGURES

FIG. **1** is a plan view of a known crimping die assembly;

FIG. **2** is a side view of the assembly shown in FIG. **1**;

FIG. **3** is a plan view of a portion of a carrier strip and electrical terminals;

FIG. **4** is an isometric view of a crimping tool incorporating the teachings of the present invention;

FIG. **5** is a plan view of the tool shown in FIG. **4**;

FIG. **6** is a cross-sectional view taken along the lines **6—6** in FIG. **5**;

FIG. **7** is a front view of the tool shown in FIG. **5**;

FIGS. **8** and **9** are front and top views, respectively of the lower portion of the housing;

FIG. **10** is a cross-sectional view taken along the lines **10—10** in FIG. **8**;

FIGS. **11**, **12**, **13**, and **14** are top, front, bottom, and side views, respectively, of the upper portion of the housing;

FIGS. **15**, **16**, and **17** are front, top, and side views, respectively, of the cam shown in FIG. **5**;

FIGS. **18** and **19** are front and top views, respectively of the carrier strip feed mechanism;

FIG. **19**A is an isometric view of an eccentric pin used in the invention;

FIG. **20** is a cross-sectional view taken along the lines **20—20** in FIG. **18**;

FIGS. **21**, **22**, and **23** are front, top, and side views, respectively, of the feed slide assembly shown in FIG. **20**;

FIGS. **24** and **25** are plan and side views, respectively, of the die holder shown in FIG. **5**;

FIG. **26** is a plan view of the die actuating member;

FIG. **27** is a front view of an indentor with crimping die; and

FIG. **28** is a plan view of a crimping die subassembly of the parts shown in FIGS. **24**, **26**, and **27**.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

There is shown in FIG. **4** a crimping tool **20** for crimping a terminal **11** onto the end of an electrical conductor **22**. The tool **20** has a main housing **24**, a terminal feed mechanism **26**, and a linear actuator **28**, which in the present example is an air cylinder, that provides the motion for operating the tool. As shown in FIG. **4**, the carrier strip **10** and attached terminals **11** are coiled about a spool **30** that is arranged at one end of the terminal feed mechanism and fed along the side of the tool and held in place by a spring loaded door **32** that is hinged to the housing **24** by means of the hinge **34**. A crimping assembly **36** having an opening **38** extends from the main housing **24** so that the opening is encircling a crimping station **40**. The crimping station **40**, being within the opening **38** has a major axis **42** that extends through the center of the opening and is coaxial with the axis **13** of a terminal **11** that is in crimping position within the crimping station. The terminal feed mechanism **26** is pivotally attached to the main housing **24** by means of a shoulder screw **44** which allows the mechanism to pivot downwardly to the position shown in phantom lines at **46** in FIG. **4** during feeding of the strip of terminals. When the axis **13** of the terminal **11** is in alignment with the major axis **42** the terminal feed mechanism **26** is pivoted upwardly to its position shown in solid lines in FIG. **4**. This moves the terminal **11** into crimping position within the crimping station **40**. This general description of the tool **20** and its operation will now be expanded and set forth in more detail below.

As shown in FIG. **7** the main housing **24** includes a bottom housing **48**, a top housing **50** and a top plate **52**. The bottom housing **48**, as best seen in FIGS. **8**, **9**, and **10** is generally of elongated shape and having a cavity **54** formed therein. A pair of rabbets **54** are formed in the opposite edges of a surface **56** and mate with a recessed surface **58** in the top housing shown in FIG. **14**. A T-slot **60**, as shown in FIG. **9**, is formed in a surface **62** of the bottom housing along an arcuate path, as best seen in FIG. **8**, for a purpose that will be explained. A relatively deep groove **64** is disposed along one edge of the surface **56** and includes an opening **66** containing a pawl **68** that is pivotally attached therein by means of a pin **70**. The pawl extends above the floor of the groove **64** a slight amount and is spring biased in a neutral position by a spring **72** and ball **74** that are held in a bore by a set screw **76**. The tip of the pawl **68** that extends above the floor of the groove **64** may be pivoted in either direction past its neutral position against the biasing force of the spring **72** for a purpose that will be explained below.

The top housing **50**, as best seen in FIGS. **11** through **14**, includes an elongated recess **78** formed in the surface **58** and a pair of grooves **80** formed in the side walls of the recess that run the length thereof. A rectangular extension **82** extends cantilever fashion from one side and end of the top housing and includes an irregularly shaped opening **84** therethrough. The crimping mechanism couples to this extension as will be described below. Another irregularly shaped opening **86** is formed through the top surface **88** of the top housing and into the recess **78** and extends into but not through the extension **82**, as best seen in FIG. **11**. An end member **90**, shown in solid lines in FIG. **7** and in phantom lines in FIG. **11** mates with both the end of the top housing **50** and the surface **56** of the bottom housing **48** and includes an internal recess **92** therein that generally conforms with the size and shape of the recess **78**. The top plate **52** is positioned against the top surface **88** of the top housing **50** and four screws **94** extend through clearance holes in the top plate, the end member, and the top housing and into threaded holes **96** formed in the bottom housing **48** to hold the entire main housing together.

A cam member **104**, as best seen in FIGS. **15**, **16**, and **17** includes a cam **106** having a first cam surface **108** and a second cam surface **110**. A cam track groove **112** is formed in one side of the cam member **104** and sized to receive a cam track follower **114** that is part of the terminal feed mechanism **26** shown in FIG. **19** and that will be described below. A pair of flanges **116** extend outwardly from opposite sides of the cam member **104** and are a slip fit with the pair of grooves **80** in the top housing **50** so that the cam member is free to slide back and forth within the cavity **78**, but constrained by the grooves **80**. A portion **118** of the cam track **112** is inclined with respect to the flanges **116** and their guiding grooves **80**. An abutting surface **120** on the lower side of the cam member **104** is arranged to abut a roller **122** that is coupled to a portion of the feed mechanism shown in FIG. **22** and that will be described below. A bayonet **124** having a tapered nose **126** extends from the leading edge of the cam member **104** and is used to actuate a funnel type wire guide mechanism **128**, as best seen in FIG. **5**. A bore **130** is formed in the end of the cam member opposite the bayonet **124**, as shown in FIGS. **15** and **16**, and is sized to closely receive the piston rod **132** of the cylinder **28**, which is pinned to the cam member **104** with a pin **134**, as best seen in FIG. **5**. The cam **104** includes a screw **131** threaded into a hole formed therein so that the threads of the screw break out along one side and form serrations **133** that are downwardly facing. When the cam member **104** is in position within the main housing the serrations **133** cooperate with the pawl **68** to prevent reversal of movement of the cam member except at either end of its stroke.

The terminal feed mechanism **26**, as shown in FIGS. **18**, **19**, and **20**, includes a frame **140** having an off-set flange **142** with a mounting surface **144** that is in substantial alignment with a surface **146** which is used to locate and help guide the movement of the carrier strip **10**, as will be explained. The cam track roller **114** is journaled for rotation on an eccentric pin **148** that extends from a hole in the surface **150** of the frame **140** opposite to the surface **146**. The eccentric pin **148**, as best seen in FIG. **19**A, includes a spindle **264** upon

which the roller **114** is journaled and a shank **266** that is sized to be a slip fit with the hole in the surface **150**. The shank **266** has several arcuate surfaces **268** equally spaced about its periphery. The eccentric pin **148** is held in the hole in the surface **150** by means of a locking pin **270**, shown in FIG. **19**A, having a threaded portion **272** that is threaded into a hole in the frame **140**. The locking pin engages one of the arcuate surfaces to secure the eccentric pin in place. The eccentric pin **148** may be angularly positioned as desired by withdrawing the locking pin **270** from the arcuate surface **268**, rotating the eccentric pin, and then reinserting the locking pin. The reason for this adjustment will be explained below. An antibackup member **274** having a knurled arcuate outer surface **276** is pivotally attached to the frame **140** by means of a pin **278**. A spring **280** is arranged to urge the antibackup member **274** to pivot in a clockwise direction. The arcuate surface **276** is formed off-center with respect to the pivot pin **278** so that as the antibackup pivots clockwise it extends past the surface **146**, and as it pivots in the opposite direction it withdraws from the surface **146**. Therefore, as the carrier strip **10** is being fed along the surface **146**, the antibackup **274** will allow the carrier strip to move only toward the off-set flange **142**, thereby preventing possible inadvertent backup of the carrier strip during feeding. A pin **152** is pressed into a hole in the surface **150** and extends outwardly from the surface and has a retaining ring **154** in a groove near its free end. As shown in FIG. **5**, the off-set flange **142** is coupled to the side of the top housing **50** by means of a shoulder screw **156** that is threaded into a hole in the top housing. The length of the shoulder screw **156** is chosen so that the surface **144** of the off-set flange is held against the side of the top housing yet the frame **140** is free to pivot about the shoulder screw without appreciable lateral play. The pin **152** extends into the T-slot **60** and is held captive there by the retaining ring **154**. The terminal feed mechanism **26** includes a removable bobbin **158** and a bobbin holder **160** that is attached to the frame **140**. The bobbin is arranged to receive a length of carrier strip **10** rolled into a coil **162**, as shown in FIG. **4**. The carrier strip is held against the surface **146** by the spring loaded door **32** and guided to the crimping station **40**. The hinge **34** is composed of interleaved ears **164** pivotally coupled with a hinge pin **166**. A spring **168** is arranged about the pin in a space between two of the ears **104**, as shown in FIG. **18**, so that the door is urged toward the surface **146**. A longitudinal groove **170** is formed in the surface **146** of the frame **140**, as best seen in FIG. **20**, for receiving a slide **172**, as best seen in FIGS. **21**, **22**, and **23**. The groove **170** is sized to be a sliding fit with the slide **172**. The roller **122** is journaled for rotation on a pin **174** that is pressed into a hole in the slide **172**. The pin **174** extends through an elongated hole **176** formed in the surface **150** of the frame **140** and past the surface **150** so that the roller **122** is positioned adjacent the surface **150**. The slide **172** includes a cutout **178** containing a compression spring **180** having one end against a back wall **182** of the slide and the other end against a projection **282** of the frame **140** that extends into the longitudinal groove **170**. The purpose of the spring **180** is to urge the slide **172** into its left most position within the groove **170**, as viewed in FIGS. **18** and **19**. As shown in FIGS. **21** and **22**, the slide **172** also includes a pair of L-shaped recesses **184**. Each recess contains a feed dog **186** which is pivotally attached to the floor of the recess by means of a pin **188**. The pins **188** are attached to the slide **182** by means of set screws **189**. Each feed dog has a tapered feed finger **190** and a compression spring **192** that urges the feed dog to pivot counterclockwise. Each feed finger **190** includes a shoulder **194** facing toward the left, as viewed in FIG. **22**. The two feed dogs are positioned so that the feed fingers are on the same spacing as the rectangular openings **15** on the carrier strip **10**. The thickness of the feed fingers is slightly less than the width of the openings **15** so that the feed fingers will easily enter the openings for feeding of the carrier strip.

When the terminal feed mechanism **26** is assembled to the main housing **24**, as described above, the roller **114** is in following engagement with the cam track groove **112** and the roller **122** is spaced from but in the path of the abutting surface **120** of the cam member **104**. Therefore, as the cam member **104** is moved from left to right, as viewed in FIG. **7**, the roller **114** tracks down the inclined portion **118** of the track thereby causing the terminal feed mechanism **26** to pivot about the shoulder screw **156** to the position shown in phantom at **46** in FIG. **4**. As the cam member **104** continues to move to the right, the abutting surface **120** engages the roller **122** causing the slide **172** to move within the longitudinal groove **170** toward the right. The tapered edge of the feed fingers **190** cam out of the rectangular openings **112** in the carrier strip **10** by compressing the springs **192**. As the cam member **104** continues to move to the right, the feed fingers ride along the surface of the carrier strip between the rectangular openings until the next set of rectangular openings are reached at which point the feed fingers are pushed into the openings by the springs **192**. By moving the cam member **104** in the opposite direction, that is to the left as viewed in FIGS. **5** and **7**, the abutting surface **120** moves to the left and the spring **180** urges the slide **172** to the left so that the roller **122** follows the abutting surface **120** until the slide reaches its position shown in FIG. **17**. While the slide is moving to the left the shoulders **194** of the feed fingers **190** move the carrier strip **10** one position to the left.

There is shown in FIGS. **24** through **28** the crimping assembly **36** and its parts. The crimping assembly includes a die member **202** having the die opening **38** in its center and an outer diameter that is concentric with the opening **38**, as seen in FIGS. **24** and **25**. The wall of the opening **38** forms a continuous surface **203**, as shown in FIG. **25**, that completely encircles the crimping station **40**, that is there is no feed notch, similar to the notch **8** shown in FIG. **2**, to interrupt the surface **203**. A crimp height adjustment stop member **204** extends from one side of the die member **202**. Four equally spaced die ways **206** are formed in the die member. Each die way **206** includes a cutout **208** formed in the periphery of the die member, a hole **210** directed radially inwardly to intersect the centerline of the opening **38**, and a counterbore **212**. Each die way **206** is sized to receive an indentor **214**, shown in FIG. **27**. Each indentor **214** includes a shank **216**, a camming head **218** and a crimping die **220**. The camming head includes an outwardly facing camming surface **222**. Each of the shanks **216** of the four indentors is a slip fit with the holes **210** so that the indentors are free to move radially toward and away from the centerline of the opening **38** and the crimping station **40**. A die actuating member **224** having a lever arm **226** extending therefrom includes an inner diameter **228** that is a slip fit with the outer diameter of the die member **202**. Four cam surfaces **230** are equally spaced about the inner diameter **228** and arranged to engage the camming surfaces **222** of the indentors **214** when the indentors are assembled in the die ways **206** and the die member positioned within the diameter **228** as shown in FIG. **28**. The four cam surfaces **230** and the surface of the inner diameter **228** form a continuous inner surface **231** that completely encircles the die member **202** so that both the die actuating member **224** and the die member **202** each completely encircle the crimping station **40**; therefore, there is no

notch or channel formed therein to accommodate the strip of tape **12** during feeding, as in prior art mechanisms. A compression spring **232** is arranged around each shank **216** between its head **218** and the bottom of the counterbore **212** to urge the surface **222** into engagement with its respective camming surface **230**. A cam follower roller **234** is journaled for rotation on a pin **236** that is rigidly attached to the end of the arm **226**. This follower roller **234** is engaged by the cam **106**, as will be explained. A pair of elongated arcuate holes **237** are formed through the die actuating member **224** spaced on opposite sides of the diameter **228** and serve as clearance openings for terminals **11** that may be on either side of the crimping station **40** during operation of the tool. The actuating member **224** includes an outside diameter **238** that is a slip fit with the arcuate walls **240** of the irregularly shaped opening **86**, see FIG. **11**. The crimping assembly **36** is arranged within the slip fit portion of the opening **86**, as shown in FIG. **5**, and is free to pivot therein. A self centering mechanism **242** has a housing **244** pivotally attached to the main housing **24** by means of a pin **246** and a piston rod **248** with its free end pivotally attached to the die actuating member **224** by means of a pin **250**. A pair of compression springs are disposed in the housing **244**, one on each side of the piston so that the piston is always urged to its center position, as shown in FIG. **5**. An adjustable stop **254** is attached to and rotated by a thumb screw **256** and is arranged to abut against the crimp height adjustment stop member **204** when the die actuating member is rotated clockwise. This limits the rotational movement of the die member **206** and thereby affects the crimp height of the tool. By rotating the thumb screw **256** to a desired setting, the adjustable stop **254** is positioned with respect to the member **204**, thereby effecting a desired crimp height.

In operation a coil **162** of carrier strip **10** and terminals **11** is loaded onto the bobbin **158** and inserted into the holder **160**. The lead end of the carrier strip **10** is threaded between the door **32** and the surface **146** of the terminal feed mechanism **26**, as shown in FIG. **4**. The cylinder **28** is then cycled a few times to bring the feed dog feed fingers **190** into engagement with the rectangular openings **15** in the carrier strip, and to advance the first terminal **11** into the crimping station **40** and into alignment with the major axis **42**. Since the vertical positioning of the terminal with respect to the crimping dies is critical, its position must be verified to be within acceptable tolerances. If it is not within acceptable limits the eccentric shaft **148** is adjusted, as set forth above, to bring the terminal into proper position for crimping. A prepared conductor **22** is then inserted into the opening **38** and the cylinder actuated. The piston **132** then advances the cam member **104** along the grooves **80** toward the right so that the cam surface **108** engages the roller **234**, as shown in FIG. **5**. As movement continues, the roller **234** tracks along the cam surface **108** thereby rotating the actuating member **224** clockwise which causes the indentors **214** to move axially in their die ways **206** toward and into crimping engagement with the terminal **11**. At this point the tapered end **126** of the bayonet **124** engages a pair of pins **258** extending from the two part wire guide **128** causing the two parts to separate and pivot about a common pivot point **260**, as best seen in FIG. **5**, for the purpose of providing additional clearance when later removing the crimped terminal and conductor. Additionally, the roller **114** engages the inclined portion **118** of the cam track groove **112** thereby causing the entire terminal feed mechanism to pivot downwardly away from the crimping mechanism **36** toward the position shown in phantom lines in FIG. **4**. Since the terminal **11** is securely gripped by the crimping dies **220**, the carrier strip **10** is pulled completely away from the terminal. As the cam member **104** continues to move to the right, as viewed in FIG. **5**, the abutting surface **120** engages the roller **122** causing the slide to advance the feed dog feed fingers **190** to disengage the current set of rectangular openings in the carrier strip **10** and to move to the next set. The carrier strip **10** is prevented from moving along with the feed dogs by the antibackup **274**, as set forth above. As the cam member **140** approaches the end of its stroke the cam **106** completely passes the roller **234** so that the roller falls off of the left end of the cam and the actuating member **224** is rotated counterclockwise to its neutral position, as shown in solid lines in FIG. **5**, by the centering mechanism **242**. This releases the crimped terminal **11** which can now be removed by simply pulling the conductor **22** and attached terminal from the opening **38**. After the cam member **140** reaches the end of its stroke it reverses direction moving toward the cylinder **28**. This causes the bayonet **124** to withdraw from the pins **258** allowing the two part wire guide to again close together and the abutting surface **120** to retreat to the left, as viewed in FIG. **5**, so that the roller **122** follows under the urging of the spring **180**. As the slide moves to the left the shoulders **194** of the feed fingers **190** advance the carrier strip **10** to bring the next terminal **11** into alignment with the major. axis **42**. As the carrier strip **10** is advanced the antibackup **274** simply pivots against the urging of the spring **280** out of the way. As the cam member **104** continues to move leftwardly, the roller **114** begins to track up the inclined cam track groove **118** causing the terminal feed mechanism **26** to pivot about the shoulder screw **156** bringing the terminal **11** toward the crimping station **42** within the die opening **38**. As this is occurring the surface **110** of the cam **106** engages the roller **234** causing it to cam downwardly, as viewed in FIG. **5**, against the urging of the centering mechanism **242** until the roller clears the right end of the cam and returns to its neutral position shown in solid lines. At this point the cam member **104** has fully retracted and the terminal **11** is in crimping position in the crimping station within the die opening. The crimping tool **20** is now ready for additional crimping operations as desired.

An important advantage of the present operation is that a crimping assembly **36** without a notch is utilized to provide a superior crimp while permitting automatic feeding of terminals by means of a carrier strip. This is made possible by the pivoting terminal feed mechanism that pivots the terminals out of the way of the crimping dies, then feeds the terminals into the next position and then pivots the terminal into the crimping station within the crimping die opening while the terminal remains in its original position on the carrier strip. Additionally, the crimping tool is economical to manufacture because all of its operating functions are effected and controlled by the linear motion of a single cam member actuated by an inexpensive air cylinder.

I claim:

**1**. In a tool for crimping an electrical terminal having an axis onto the end of an electrical conductor, said tool having a frame, a crimping station within said frame, a major axis through said crimping station, and being of the type that receives electrical terminals spaced on a carrier strip having a length, moves said strip longitudinally of its length to position a terminal in alignment with said crimping station, and removes said terminal from the carrier strip after crimping onto said conductor,

(a) a crimping apparatus comprising:

a die member having an opening and a plurality of die ways therein intersecting said opening, said opening having a wall forming a continuous surface com-

pletely encircling said crimping station;

a plurality of crimping dies arranged in said die ways to move toward said crimping station and into crimping engagement with a terminal in position therein with its axis co-axial to said major axis;

a die actuating member having continuous inner surface completely encircling said die member and said crimping station, said die actuating member arranged to effect said movement of said crimping dies within said die ways; and

(b) a terminal feed mechanism arranged to move said carrier strip substantially laterally of its length so that a said terminal is moved substantially axially along said major axis into said position in said crimping station.

**2**. The tool according to claim **1** wherein said die ways have longitudinal axes radially arranged with said crimping station in the center thereof and when said crimping dies undergo said movement each die moves along a respective said longitudinal axis.

**3**. The tool according to claim **2** wherein said die member is a solid ring having an inside opening, said crimping station being within said inside opening.

**4**. The tool according to claim **3** wherein said means for effecting said movement of said crimping dies includes a die actuating member having an inside diameter and said die member having an outside diameter that is a slip fit within said inside diameter so that said die actuating member can rotate about said die member, the die actuating member having camming surfaces formed in said inside diameter and arranged so that when undergoing said rotation in a first rotational direction said camming surfaces interact with said crimping dies for effecting said movement thereof toward said crimping station.

**5**. The tool according to claim **4** wherein said axis of said inside diameter of said die actuating member is co-axial with said major axis and said longitudinal axes of said die ways are substantially perpendicular to said major axis.

**6**. The tool according to claim **5** including a first cam follower associated with said die actuating member and a first cam arranged to move within said frame in a first linear direction to engage said first cam follower and effect said rotation of said die actuating member in said first rotational direction.

**7**. The tool according to claim **1** wherein said die actuating member is arranged to rotate in a first rotational direction to effect said movement of said crimping dies toward said crimping station and into said crimping engagement, wherein said die actuating member has a cam follower associated therewith and said tool includes a first cam arranged to move in a first linear direction to engage said first cam follower and effect said rotation of said die actuating member in said first rotational direction.

**8**. The tool according to claim **7** wherein said first cam follower has a neutral position where said crimping dies are not in said crimping engagement and a closed position where said crimping dies are in said crimping engagement, so that as said first cam moves in said first linear direction and engages said first follower, said first follower is moved from its neutral position to its closed position.

**9**. The tool according to claim **8** including bias means for urging said first follower into said neutral position so that as said first cam moves in said first linear direction and engages said first follower and moves said first follower from its neutral position to its closed position, further movement of said first cam in said first linear direction causes said first follower to disengage said first cam and return to said neutral position.

**10**. The tool according to claim **9** wherein said first cam is arranged so that after said further movement thereof and upon moving said first cam in a second linear direction opposite to said first linear direction, said cam engages said first follower and moves it away from both said neutral and closed positions until said follower disengages said first cam and returns to said neutral position under the urging of said bias means.

**11**. The tool according to claim **10** wherein said first cam includes a front cam surface that engages said first follower during a portion of said movement in said first linear direction and a back cam surface, substantially opposite said front cam surface that engages said first follower during a portion of said movement in said second linear direction.

**12**. The tool according to claim **1** wherein said terminal feed mechanism includes a guide member having a track for positioning and guiding said carrier strip so that the axis of a first terminal on said carrier strip is substantially parallel with said major axis, including means for moving said carrier strip along said track thereby moving said first terminal into said position within said crimping station.

**13**. The tool according to claim **12** wherein said guide member is pivotally attached to said frame and arranged for pivotal movement away from and toward said crimping apparatus in a plane that is substantially parallel with said major axis so that said terminal can be pivoted away from said crimping station, then moved along said track by said means for moving until the axis of said terminal is adjacent said major axis, then pivoted toward said crimping station into said position.

**14**. The tool according to claim **13** wherein said guide member includes a second follower associated therewith and said tool includes a slide arranged to move within said frame in a first linear direction and in a second linear direction opposite to said first linear direction, said slide having a cam track therein in operational engagement with said second follower and arranged so that movement of said slide in said first and second linear directions causes said guide member to undergo said pivotal movement away from and toward said crimping apparatus, respectively.

**15**. The tool according to claim **14** wherein said means for moving comprises a feed dog adjacent said track and having an abutting member associated therewith that is engageable by said slide so that when said slide is undergoing said movement in said first linear direction, for at least a portion of said movement, said slide moves said feed dog into engagement with said carrier strip and moves said carrier strip along said track.

**16**. The tool according to claim **14** wherein said die actuating member is arranged to rotate in a first rotational direction to effect said movement of said crimping dies toward said crimping station, wherein said die actuating member has a cam follower associated therewith and said tool includes a first cam arranged to move in a first linear direction to engage said first cam follower and effect said rotation of said die actuating member in said first rotational direction, wherein said first cam is rigidly attached to and is carried by said slide.

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